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STUDY ON GREEN CONCRETE

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ABSTRACT

Cement and concrete may have an important role to play to fulfil its obligation, agreed at the conference, to reduce the total CO2 emission by 21 % . This is because approximately 2 % of total CO2 emission stems from cement and concrete production. There is considerable knowledge about how to produce concrete with a reduced environmental impact. However, it is not known to a sufficient degree, and with what technology, this "green" concrete can be applied in practice in buildings and structures. For instance, there is not enough information about how the properties of green concrete, such as compressive strength, durability, fire performance, casting and execution, hardening, and curing are affected by the measures to reduce the environmental impact of concrete. This paper gives an overview of the present state of affairs of concrete types that have reduced environmental impact, including the use of low energy cement, recycling of crushed concrete as aggregate, the use of fly ash and micro silica, etc. There is a description of among other things the possibilities of using "green" concrete within the existing standards and specifications, research projects about green concrete, life cycle assessments, etc. The potential environmental benefit to society of being able to build with "green" concrete is huge.

Keywords *- conference, Green concrete, Concrete mix design, Packing calculation, Demo bridge, Specifications, Environmental management, Life cycle assessment, Cleaner technologies.*

INTRODUCTION

The concrete is made with concrete wastes which are eco-friendly so called as Green concrete.The other name for green concrete is resource saving structures with reduced environmental impact for e.g. Energy saving, co2 emissions, waste water.Green concrete is a revolutionary topic in the history of concrete industry. This was first invented in Denmark in the year 1998 by Dr.WG

CEMENT AND CONCRETE'S ROLE IN MEETING THE ENVIRONMENTAL OBLIGATIONS

Cement and concrete may have an important role to play in enabling to fulfil its obligation to reduce the total CO2 emission by 21 % compared to the 1990- level before 2012, as agreed at the conference. This is because the volume of concrete consumption is large in Denmark. Approx. 1.5 tonnes of concrete per capita are produced annually. The CO2 emission related to concrete production, inclusive of cement production, is between 0.1-0.2 tons per ton produced concrete. This corresponds to a total quantity of CO2 emission of 0.6 - 1.2 m tons per year. The potential environmental benefit to society of being able to build with green concrete is huge. It is realistic to assume that technology can be developed which can halve the CO_2 emission related to concrete production. The somewhat soft demands in the form of environmental obligations result in rather specific technical requirements for the industry - including the concrete industry. These technical requirements include among others new concrete mix designs, new raw materials, and new knowledge (practical experience and technical models) about the properties of the new raw materials and concrete mix designs

WHY GREEN CONCRETE?

– Huge impact on sustainability
– Most widely used material on Earth
• 30% of all materials flows on the planet
– 70% of all materials flows in the built environment.
• > 2.1 billion tonnes per annum.
• >15 billion tonnes poured each year.
• Over 2 tonnes per person per annum

Discussions with the Ministry of Environment and Energy, Environmental Protection Agency have resulted in the following priorities regarding environmental impacts relevant to concrete (2).

High priority

- CO_2
- Resource (water)
- Fossil fuel (oil, coal)
- Substances harmful to health or environment (chemicals, heavy metals)

Medium priority

- SO_2 and NO_X
- Local supply of resources such as sand, stone, gravel, chalk and lime
- Resource (recycling of waste)

Low priority

- Volatile Organic Compounds (only relevant to the working environment)

STATE OF AFFAIRS OF CONCRETE WITH REDUCED ENVIRONMENTAL IMPACT

There is considerable knowledge about how to produce concrete with lower environmental impact, so-called green concrete. The concrete industry has considerable experience in dealing with environmental aspects. The concrete industry realised at an early stage that it is a good idea to be in front with regard to documenting the actual environmental aspects and working on improving the environment, rather than being forced to deal with environmental aspects due to demands from authorities, customers and economic effects such as imposed taxes, etc.
The knowledge and experience, about how to produce concrete with lower environmental impacts can be divided into two groups, concrete mix design and cement and concrete production:

Concrete mix design:

- using cement with reduced environmental impacts - minimising cement content
- substituting cement with pozzolanic materials such as fly ash and micro silica
- recycling of aggregate
- recycling of water.

Cement and concrete production:

- environmental management

CONCRETE MIX DESIGN

The type and amount of cement has a major influence on the environmental properties of a concrete. An example of this is shown in figure 1, where the energy consumption in MJ/kg of a concrete edge beam through all the life cycle phases is illustrated. The energy consumption of cement production make up more than 90 % of the total energy consumption of all constituent materials and approximately 1/3 of the total life cycle energy consumption.

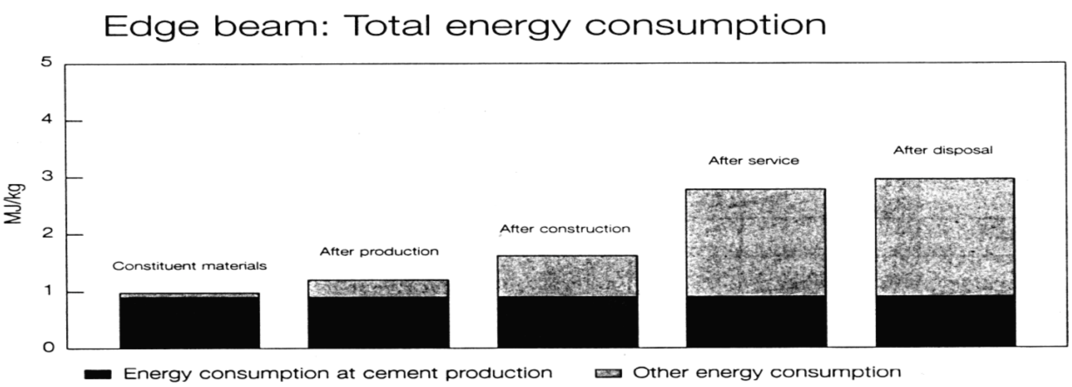

Figure 1. Edge beam: Total energy consumption through all the life cycle phases

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By selecting a cement type with reduced environmental impacts, and by minimising the amount of cement the concrete's environmental properties are drastically changed. This must, however, be done whilst still taking account of the technical requirements of the concrete for the type and amount of cement.

Table, Requirements on the content of fly ash and micro silica according to the future

Extra Aggressive environmental class	Aggressive environmental class	Moderate environmenta l class	Passive environmental class	
25	25	35	no requirements	Max. content of FA+MS in % of C+FA+MS
10	10	10	no requirements	Max content of MS in % of C+FA+MS

C=cement, FA= Fly Ash, MS= Micro Silica

One method of minimising the cement content in a concrete mix is by using packing calculations to determine the optimum composition of the aggregate.

A high level of aggregate packing reduces the cavities between the aggregates, and thereby the need for cement puste. This results in better concrete properties and a better environmental profile, due to a smaller amount of cement. When having experimentally determined the packing, the density, and the grain size distribution of each aggregate material, it is possible to calculate the packing of any combination of aggregates using DTI Concrete Centre's computer program

ENVIRONMENTAL GOALS

The centre's preliminary environmental goals which green concrete has to fulfil are as follows:

1) Reduction of CO2 emissions by 21 %. This is in accordance with the Kyoto obligation as described previously.
2) Increase the use of inorganic residual products from industries other than the concrete industry by approx. 20%.
   Reduce the use of fossil fuels by increasing the use of waste derived fuels in the cement industry. The reduction percentage has not yet been determined.
3) Avoid the use of materials from the list of unwanted materials prepared by the Environmental Protection Agency. These materials can for instance be form oil and additives.
4) The recycling capacity of the green concrete must not be less compared to existing concrete types.
5) The production of green concrete must not reduce the recycling applicability of the discharged water.

6) The production and the use of green concrete must not deteriorate the working environment.

ENVIRONMENTAL BENEFITS TO USING GREEN CONCRETE

Geopolymer concrete, or **green concrete**, is part of a movement to create construction materials that have a reduced impact on the environment. It is made from a combination of an inorganic polymer and 25 to 100 percent industrial waste. Here is a list of 4 benefits to using green concrete for your next project.

a. Lasts Longer

Green concrete gains strength faster and has a lower rate of shrinkage than concrete made only from Portland Cement. Structures built using green concrete have a better chance of surviving a fire (it can withstand temperatures of up to 2400 degrees on the Fahrenheit scale). It also has a greater resistance to corrosion which is important with the effect pollution has had on the environment (acid rain greatly reduces the longevity of traditional building materials). All of those factors add up to a building that will last much longer than one made with ordinary concrete. Similar concrete mixtures have been found in ancient Roman structures and this material was also used in the Ukraine in the 1950s and 1960s. Over 40 years later those Ukrainian buildings are still standing. If buildings aren't constantly having to be rebuilt, fewer construction materials are needed and the impact to the environment during the process of making those materials is reduced.

b. Uses Industrial Waste

Instead of a 100 percent Portland cement mixture, green concrete uses anywhere from 25 to 100 percent fly ash. Fly ash is a byproduct of coal combustion and is gathered from the chimneys of industrial plants (such as power plants) that use coal as a power source.

There are copious amounts of this industrial waste product. Hundreds of thousands of acres of land are used to dispose of fly ash. A large increase in the use of green concrete in construction will provide a way to use up fly ash and hopefully free many acres of land.

c. Reduces Energy Consumption

If you use less Portland cement and more fly ash when mixing concrete, then you will use less energy. The materials that are used in Portland cement require huge amounts of coal or natural gas to heat it up to the appropriate temperature to turn them into Portland cement. Fly ash already exists as a byproduct of another industrial process so you are not expending much more energy to use it to create green concrete.

d. Reduces CO_2 Emissions

In order to make Portland cement–one of the main ingredients in ordinary cement– pulverised limestone, clay, and sand are heated to 1450 degrees C using natural gas or coal as a fuel. This process is responsible for 5 to 8 percent of all carbon dioxide (CO2) emissions worldwide. The manufacturing of green concrete releases has up to 80 percent fewer CO2 emissions. As a part of a global effort to reduce emissions, switching over completely to using green concrete for construction will help considerably.

THREE DIFFERENT WAYS TO PRODUCE GREEN CONCRETE

In three different development projects in the centre, green concrete is examined in three different ways:

1) To minimise the clinker content, i.e. by replacing cement with fly ash, micro silica in larger amounts than are allowed today, or by using extended cement, i.e. Portland limestone cement. The preliminary plan is to analyse concrete for passive environmental class with fly ash amounts of up to 60% of the total amount of cement and fly ash, concrete for aggressive environmental class with Portland limestone cement, and concrete for passive environmental class with dry desulphurization products.
2) To develop new green cements and binding materials, i.e. by increasing the use of alternative raw materials and alternative fuels, and by developing/improving cement with low energy consumption. A new, rapid hardening low energy cement based on mineralized clinker is currently ready for testing.

3) Concrete with inorganic residual products (stone dust, crushed concrete as aggregate in quantities and for areas that are not allowed today) and cement stabilised foundation with waste incinerator slag, low quality fly ash or other inorganic residual products. Currently an information-screening of potential inorganic residual products is carried out. The products are described by origin, amounts, particle size and geometry, chemical composition and possible environmental impacts. From this information-screening approximately 5 products will be selected and analysed for use in green concrete. Approximately 3-5 materials will be selected for testing in cement stabilised foundations.

All the above mentioned green concrete types will be tested for workability, changes in the workability after 30 minutes, air content, compressive strength development, E-modules, heat development, homogenity, water separation, setting, density, and pumpability. Furthermore, the water/cement ratio, water/binder ratio, and the chloride content will be calculated.

From the tests, the most promising green concrete will be selected and exposed to more advanced testing.

CONCLUSION

The overview of the present state of affairs of concrete types with reduced environmental impact has shown that there is considerable knowledge and experience on the subject. The environmental policies have motivated the concrete industry to react, and will probably also motivate further development of the production and use of concrete with reduced environmental impact.

The somewhat vague environmental requirements that exist have resulted in a need for more specific technical requirements, and this is the focus of a recently started, large, research project, where the most important goal is to develop the technology necessary to produce and use resource saving concrete structures, i.e. green concrete. This applies to structure design, specification, manufacturing, performance, operation, and maintenance.
The potential environmental benefit to society of being able to build with green concrete is huge. It is realistic to assume that the technology can be developed, which can halve the CO_2 emission related to concrete production, and with the large energy consumption of concrete and the following large emission of CO_2 this will mean a potential reduction of Denmark's total CO_2 emission by ½ -1%.

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